

National Aeronautics and
Space Administration

Educational Product	
Educators	Grades 5-12
LS-1999-05-001-HQ	

Exploring Earth From Space

Lithograph Set and Instructional Materials

Shuttle astronauts and the NASA EarthKAM program provide photographs of our planet from the unique perspective of Earth orbit. They are an incredible resource that can enhance your students' studies of science, mathematics, technology, and geography.

This *Exploring Earth From Space* Lithograph Set includes:

- Teacher Background with
Student Information Sheets and
Student Worksheet

- 13 lithographs:

Space Cameras

Earth Features Seen From Space

Buenos Aires, Argentina

Mississippi River Delta

Río Salado, Argentina

Northeast Coast of Australia

Gazankulu Homeland, South Africa

Ganges River Delta

Creative Agriculture in Response to Limited Water

Deforestation in Rondonia, Brazil

Cloud Patterns

Eruption of Klyuchevskaya Volcano in Kamchatka

Forest Fires in Sumatra



1. Shuttle Photography

Astronauts love to look out the windows of the Space Shuttle, and fortunately, they also love to take photographs of what they see. For example, shortly after launch on September 30, 1994, the astronauts were looking out the windows of the Shuttle when they noticed thick, black smoke over the Kamchatka Peninsula in north-east Russia. On the next orbit, they took photographs, and thus captured the eruption of the Klyuchevskaya volcano on film.

Over the years, astronauts have taken more than 350,000 high-resolution color photographs. These photos reveal Earth as never seen before, showing deforestation in Brazil, the delta of the Mississippi River, the streets and buildings of Buenos Aires, and much more. This collection has been extended even further by students. Through the NASA EarthKAM program, students have been able to take photographs of Earth from space. Unable to look out the Shuttle's windows, they tracked the Shuttle and instructed a camera mounted in one of the windows when to take photographs.

Materials

What You Will Need:

- Atlases/maps
- Rulers
- References on the areas shown in the photographs (e.g. travel guides, encyclopedias, and Web sites)
- References about the topic being studied (e.g. clouds or deforestation)



2. Familiarizing Yourself With the Lithographs

We recommend that you spend time examining the lithographs—identifying features, locating them on maps, asking questions, etc.—before you introduce them in your classroom. See *Earth Features Seen From Space* and the student sheets; they should be helpful to you as well.

3. Introducing the Lithographs to Your Students

Introduce the Photographs:

When presenting the lithographs to your students, explain that they are visible light photographs taken from the Space Shuttle. Emphasize that they were taken by a person—either an astronaut looking out the Shuttle windows or an EarthKAM student tracking the Shuttle in the classroom. (See the lithograph *Space Cameras System*.)

Explore a Photograph:

Have your students examine one of the photographs in detail. This examination involves three stages: Getting Interested, Getting Oriented, and Getting Deeper. The *Student Worksheet* can help you guide the first two stages. (Do not allow your students to read the back of the lithograph until they have considered the color photograph.) For the third stage, encourage your students to use atlases and other references to extend their exploration of the photograph. (See next page.)

Brainstorm Questions:

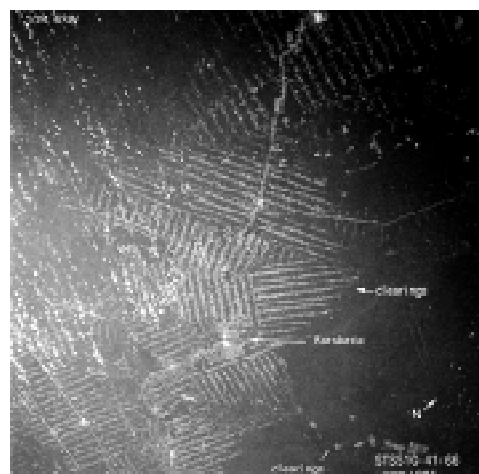
Throughout your students' work with the lithographs, prompt them to record their questions and speculations. Working with Earth photographs involves asking questions about (a) what is there, (b) why it is there, (c) how it got there, (d) what effects it has, and (e) what all of this suggests about an area or topic. This brainstorming is most successful if done as a class, and it is an essential step in Getting Deeper.

4. Integrating the Lithographs Into Your Curriculum

Earth photographs can spark student interest, be sources of questions and data, and even serve as assessment pieces. Here are some specific topic ideas to help you begin using the lithographs in your classroom.

Change Over Time

The lithographs, and other EarthKAM and Shuttle photographs, can be used to study change over time by (a) comparing photographs of the same area taken at different times or (b) inferring changes (past or future) from the features seen. For example, *Deforestation in*

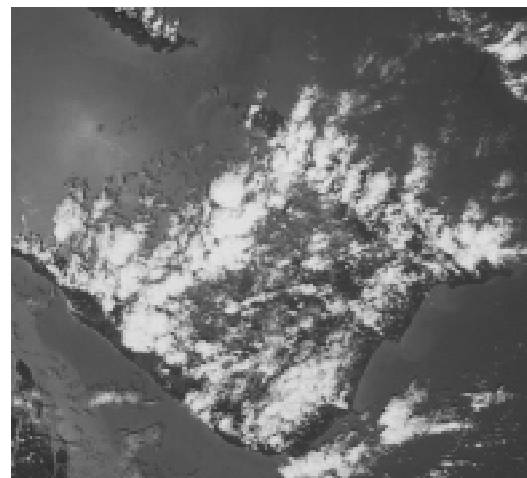


Rondonia, Brazil shows two photographs of deforestation taken 11 years apart. This is a good starting point for studying the social, economic, and environmental issues involved in deforestation. Students can clearly see the changes that have taken place and can speculate on what is causing them and how the area may look in the future.

Mississippi River Delta shows the present river delta, the remnants of an old delta, and human settlements on the river and coast. Students can research why the delta shifts, the implications, and the effects of human construction.

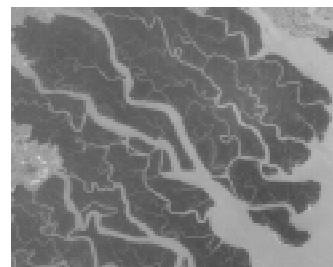
Weather

One primary factor influencing weather is the difference in the heat-holding capacities of land and water. By studying *Cloud Patterns*, students can postulate a relationship between clouds and water or land and speculate on its causes. Once they have studied the phenomenon, other cloud photographs can be used for assessment, as students hypothesize the conditions that resulted in the cloud patterns shown. Students can also download live images of clouds from weather sites on the Web.



Patterns

EarthKAM and Shuttle photographs, because of their scale, are particularly good for seeing large-scale patterns (or shapes) on Earth's surface. Students can see physical patterns such as drainage networks and sea eddies (*Northeast Coast of Australia*) or human impact patterns such as radial transportation lines (*Buenos Aires, Argentina*). Often there are links between the physical and human patterns, as in the agricultural fields along the river in *Ri  Salado*. Encourage students to find patterns, to sketch them, and to ask the key question: why did each pattern occur?



Cataclysmic Events

Photographs capture moments in time, so they are an excellent way to study cataclysmic events such as erupting volcanoes (*Eruption of Klyuchevskaya Volcano in Kamchatka*) and forest fires (*Forest Fires in Sumatra*). These two events are particularly interesting because they had both local and global repercussions. Students can study these lithographs, research the events, and speculate on their impacts on physical and human environments.

Human Impact

Both positive and negative impacts of people on the environment can be seen in the lithographs. *Gazankulu Homeland, South Africa* and *Ganges River Delta* show side-by-side areas of settlement and conservation. Students can explore the reasons for and the effects of these manipulations of our planet.



Students can also see that agriculture is radically altering Earth's surface. *Ri  Salado, Argentina* and *Creative Agriculture in Response to Limited Water* focus on agriculture, but *Buenos Aires, Argentina* and *Northeast Coast of Australia* also show large regions of farmland. Students can consider the importance and impact of agriculture, especially when considered in relationship with natural vegetation, water sources, and cities.

Cultures

The lithographs can be used as an entry to the study of a regional culture. For example, *Gazankulu Homeland, South Africa* shows both rural ghettos and a national park. This provides a visible outcome of the social and political changes occurring in South Africa.

Buenos Aires, Argentina shows a city with docks, streets, an airport, parks, and a racetrack. By studying the photograph, students can choose topics of interest to research, such as horse racing or importing and exporting by water, and learn about the culture of Buenos Aires.

Mathematics

Using the lithographs, atlases, and rulers, students can learn about measurement, proportionality, graphing, and more. For example, the relationship between length and width is constant for the EarthKAM photographs; students can determine this relationship by plotting length vs. width and finding the slope. Other possible calculations include conversions between the scale of a photograph and the scale of an atlas—measuring and calculating the size of features in the photographs.

5. Resources

This guide and the student sheets can be used with other photographs of Earth taken from space. The following resources can help you find additional images and resources for use in your classroom. Also check your local library, the Web, and your NASA Educator Resource Center.

Books

Earth From Space: This small paperback guide is an excellent introduction to studying Earth using various types of images. Text by Dr. Amy Leventer and Dr. Geoffrey Seltzer, National Audubon Society Pocket Guide, Alfred A. Knopf, 1995; ISBN: 0679760571

Looking at Earth: This topographical portrait of Earth, organized by region, includes stunning visual photographs collected by spacecraft and remote-sensing equipment. Priscilla Strain and Frederick Engle, National Air and Space Museum Smithsonian Institution and Turner Pub; ISBN: 1878685163 (out of print; check libraries or book search Web sites)

Mission: Earth, Voyage to the Home Planet: A first-hand account of an astronaut's journey on the Space Shuttle Endeavor recounts his mission to study the health of the planet. Thomas D. Jones and June A. English, Scholastic Press, 1996; ISBN: 0590485717

National Geographic Satellite Atlas of the World: In this unique atlas, remotely-sensed photographs (of all types), maps, and information are interconnected and organized by geographic region. National Geographic Society, 1998; ISBN: 0792272161

Orbit: NASA Astronauts Photograph the Earth: This book contains high quality photographs taken by Shuttle astronauts. J. Apt, M. Helfert, J. Wilkinson, R. Ressmeyer, National Geographic Society, 1996; ISBN: 0792237145

Seeing Earth From Space: This book begins with photographs of Earth taken from the Moon and then moves on to photographs taken by astronauts orbiting the planet. Patricia Lauber, Orchard Books, 1990; ISBN: 0531059022

The Third Planet: Astronaut Sally Ride looks back at Earth, showing what the view reveals about our planet's environment and humanity's impact on it. Sally Ride and Tam O'Shaughnessy, Crown Publishers, 1994; ISBN: 0517593610

Web Sites

EarthRISE: Photographs of Earth taken by Shuttle astronauts are available here. They can be searched by key word (Form) and by map (Political and Topographical). < <http://earthrise.sdsc.edu/> >

JSC Earth From Space: Many of the best astronaut-acquired photographs of Earth are available at this site. The photos can be searched easily by areas of interest: cities, weather, features, technical, etc.
< <http://earth.jsc.nasa.gov> >

NASA EarthKAM: EarthKAM photographs, including those in this lithograph set, as well as an educator's guide and other classroom materials are available at this Web site. (See Datasystem to search the photographs.)
< <http://www.earthkam.ucsd.edu> >

NASA Education Home Page: This page serves as a cyber-gateway to information regarding educational programs and services offered by NASA for educators and students across the United States.
< <http://education.nasa.gov/> >

NASA Office of Earth Science: This NASA site focuses on our home planet, Earth. You can find details on current events in Earth science, NASA Earth science missions, Earth images, and educator resources.
< <http://www.earth.nasa.gov> >

NASA Office of Space Flight: Here you will find information on the Space Shuttle, the International Space Station, the Mir Space Station, rocket launches, and other programs that are exploring, using, and enabling the development of space. < <http://www.hq.nasa.gov/osf/> >

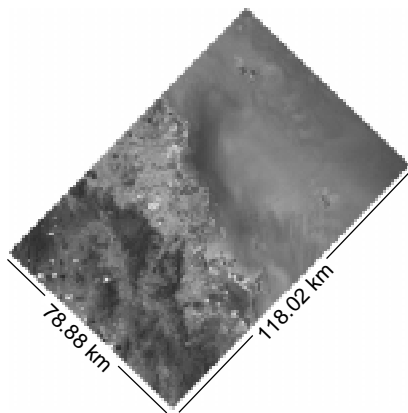
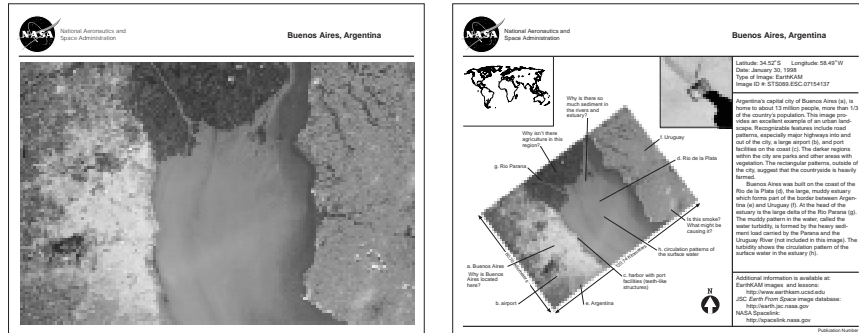
NASA Spacelink: Specifically for the educational community, Spacelink provides links to virtually every one of NASA's Web sites and resources, including programs, educator materials and opportunities, current events, etc.
< <http://spacelink.nasa.gov> >

Terraserver: Terraserver has a collection of very high-resolution aerial photographs and satellite images. You can order prints of individual images. Search by name, map, or latitude and longitude coordinates.
< www.terraserver.com >

Exploring Earth From Space

Student Information Sheet

Astronauts love to look out the windows of the Space Shuttle, and fortunately, they love to take photographs of what they see. Recently, through a NASA program called EarthKAM, students have also been able to take photographs of Earth from space. Although they were unable to look out the Shuttle's windows, those students tracked the Shuttle and instructed a camera mounted in one of the windows when to take a photograph. You are going to explore both kinds of photos.



Scale

The scale of a photograph taken from the Shuttle depends on (a) the camera and lens used, (b) the altitude of the Shuttle when the photograph was taken, and (c) the angle of the camera—straight down or oblique. In general, EarthKAM photographs show an area about 120 km by 80 km. The scale of the Shuttle astronaut photographs varies more. (See the backs of the color photographs for exact dimensions.)

Colors

The photographs you will be exploring are all *visible light* images, meaning they show what you would see if you looked out a window of the Shuttle. However, the processing and printing of the photographs has changed the colors slightly—they appear somewhat redder than they should.

These Colors:

blues
black, dark blue, or dark green
white
red, orange, peach, or brown

Can Indicate:

water
vegetation
clouds, snow, or human impact
ground, soil, or sediment

Earth Features

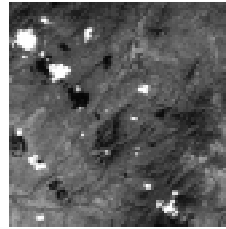
You can identify features by examining their appearance in the photographs and then comparing them to maps of the same area. In addition, many features are identified on the back of each color photograph.



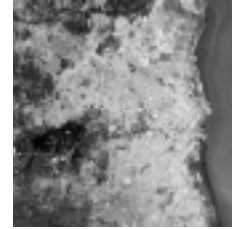
mountains



agriculture



clouds



urban development

Image Identification Number

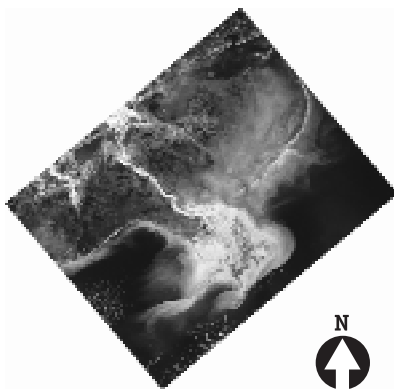
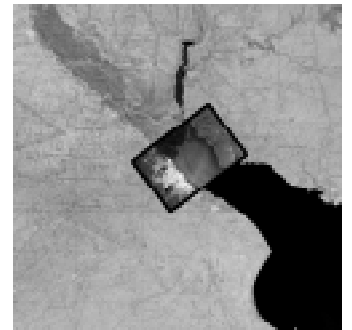
NASA uses image identification (ID) numbers, such as STS089.ESC.07154137 or STS051G-41-66, to identify each photograph taken from the Space Shuttle. These numbers contain information about when and how the photograph was taken. For example, the image identification number of an EarthKAM photograph has three parts:

- the Shuttle mission (*e.g.*, STS089),
- the type of camera (*e.g.*, ESC for Electronic Still Camera), and
- the time (*e.g.*, 07154137—the photograph was taken 07 days, 15 hours, 41 minutes, and 37 seconds after the Shuttle launched).

You should always record the image ID number for any photograph you study.

Location

Latitude and longitude are provided on the back of each color photograph. These coordinates pinpoint the center of the photograph and can locate the area on a map. (Small maps also appear on the back of the photographs to help get you started.) By comparing the photograph and maps, you can (a) identify the features shown and (b) learn about the area in, and surrounding, the photographs.



North

For the color photographs, the top of the page is NOT north. When possible, the back shows black and white versions of the photographs rotated so the top is north. This will help you (a) align the photos with maps and (b) identify directions, such as which way a river is flowing or the wind is blowing.

Exploring Earth From Space

Student Worksheet

Examine the Color Photograph

1. Photograph Name: _____
2. Describe the photograph:
 - a. What shapes, colors, textures, and patterns do you see?

 - b. What features, such as rivers, mountains or cities, can you identify?

 - c. What questions do you have about what you see?

Record the Photograph Data

1. Image Identification (ID) Number: _____
2. Center Latitude: _____ Center Longitude: _____
3. Now that you've looked at the annotated photograph and read its description, what facts or features or aspects interest you the most? Why?

Find the Area on a Map

1. Describe the location of the photograph so that someone else could find it in an atlas:
 - a. What country/countries does it show?

 - b. What specific features can you name?

 - c. What does the surrounding area look like/contain?
2. What questions do you have now about this photograph?